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## Xylem of Dashamoola

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**Abstract**

Dashamoola, an Ayurvedic formulation comprising ten roots from medicinal plants, has been extensively studied for its roots xylem vessels, fibres and ray cells. This study focuses on the xylem tissue of the constituent plants of Dashamoola. Xylem, primarily responsible for water and nutrient transport, plays a critical role in the overall medicinal efficacy of the formulation. The anatomical features, structural variations of the xylem were examined using maceration techniques. The investigation revealed significant variations in the xylem vessels, fibres and ray cells structure among the ten species roots of Dashamoola. Vessels are elongated, cylindrical, barrel shaped, one side tapering end to both side tapering ends, broad to narrow pitted, reticulate to scalariform vessels types are present in these plants. These variations include differences in vessels type, diameter and arrangements, as well as the presence of specific characters in each species.

**Keywords:** Dashamoola, medicinal plants, maceration, Xylem

**Introduction**

The demand for Ayurvedic products, including Dashamoola, is rising globally due to an increased interest in natural and holistic health approaches. In India, Dashamoola is widely used in traditional Ayurvedic practice, contributing significantly to the local economy. Medicinal plants play a crucial role in the traditional system of indigenous medicine (Saleem, *et al.*, 2001) [7]. All Indian system of medicine mainly focus their attention on natural products that help the human race to sustain longer and stronger life (Shrestha & Dhillion, 2003) [8]. Dashamoola is thought to be one of the most powerful combinations of several plants utilized in Ayurveda and also according to Ayurveda, it works primarily on the Vata Dosha, reducing its aggravation and also affects the pelvis, bladder, colon, kidney, bones, ears, and lower limbs, which are all Vata organs (Poonam, *et al.*, 2022 & Akshay, *et al.*, 2014) [6, 2]. The roots of five trees are known as Brihat Panchmoola and the roots of five sub shrubs and herbs are known as Laghu panchmoola. Details of Dashamoola: Five trees are *Aegle marmelos* (L.) Correa; *Clerodendrum phlomidis* L.f.; *Oroxylum indicum* (L.) Kurz; *Stereospermum chelonoides* (L.f) DC, *Gmelina arborea* Roxb. ex Sm. (FIG-1). Five herbs and sub shrubs are; *Tribulus terrestris* L.; *Desmodium gangeticum* (L.) DC.; *Urarica picta* (jacq.) Desv. ex. DC.; *Solanum virginianum* L.; *S. anguivi*. Dashamoola is prepared by mixing the equal parts of these roots. It has a balance of vata, pitta and kapha known as Tridosha Nashak. In Ayurvedic medicine, the poly herbal combination is one of the most common ingredients used to prepare many forms of medicine used for treatment of various ailments, especially Vata Roga (Poonam, *et al.*, 2022 & Chandan *et al.*, 2019) [6, 3]. There is an immediate need to have standards for all medicinal plant with there are several technique and methodology and pharmacognostic and phytochemical studies is one of such tools. (Ahmed, *et al.*, 2006) [1]. Proper identification ensures consistency in the composition of Dashamoola, which is crucial for maintaining its therapeutic efficacy. By ensuring the correct botanical identity of the plants used in Dashamoola, the research aids in establishing stringent quality control measures for its production and trade. Accurate botanical identification helps prevent the use of incorrect adulterated plant materials, which can compromise the safety and effectiveness of the formulation. Adherence to quality standard, such as those set by AYUSH in India, ensures the safety and efficacy of the products. For this purpose, microscopical studies on the xylem are carried out in this study. The current study the xylem of Dashamoola on vessels, fibres and ray cells with shape, type, thick, length and width of each species used by maceration technique.

## Materials and Methods

**Sample collection:** Dashamoola dried plant samples of were used from samples deposited at FRLH National medicinal plants herbarium and repository of raw drug, TDU, Bangalore Karnataka. Details of root samples (Table – 1).

The dried materials of mature roots were cut into small slices or slivers about 300 micrometres thick. Then soaked in macerated solution of equal part of 10% aqueous nitric acid and 10% aqueous chromic acid. This solution kept into the 60<sup>0</sup>c in hot air oven for 24 hours (Jeffery, 1917) [4].

Maceration is a technique of softening the plant tissue by soaking in a liquid and then observing the material in microscope. Here we have taken the 10 root samples of Dashamoola to study the xylem of each species.

Macerated plant material is excellent for the study of xylem. A small quantity of the macerated tissues stained with safranin and TBO mounted with glycerin. All the photomicrographs were taken using Olympus CX 33 light microscope.

**Table 1:** Samples information and source of the 10 plants of Dashamoola

Sl. No.	Date of collection	Collector	Collection No.	Locality	State	Botanical name	Family	Habit	Trade name
1	28/09/2011	K Ravi Kumar, N Balachandran	2032	Nimmala palyan	Andhra Pradesh	<i>Aegle marmelos</i>	Rutaceae	Tree	Bilva
2	18/06/2011	M V Sumanth	2022	S R M University campus	Tamil Nadu	<i>Clerodendrum phlomidis</i>	Verbenaceae	Small tree	Agnimantha
3	10/11/2010	K Ravi Kumar, R Murugan	1647	Jabbar MPCA	Chhattisgarh	<i>Desmodium gangeticum</i>	Fabaceae	Sub shrub	Shalparani
4	26/03/2011	M V Sumanth	1591	Municipal market	Kerala	<i>Gmelina arborea</i>	Verbenaceae	Tree	Gambhari
5	13/11/2001	K Ravi Kumar, R Murugan	1678	Jabbara MPCA	Chhattisgarh	<i>Oroxylum indicum</i>	Bignoniaceae	Tree	Shyonak
6	16/4/2024	N Pradeep	2669	Malleswaram market	Karnataka	<i>Solanum anguivi</i>	Solanaceae	Shrub	Brihati
7	25/03/2011	M V Sumanth	1587	Antony and Co. municipal	Kerala	<i>Solanum virginianum</i>	Solanaceae	Shrub	Kantakari
8	13/11/2010	K Ravi Kumar, R Murugan	1664	Jabbara MPCA	Chhattisgarh	<i>Stereospermum chelonoides</i>	Bignoniaceae	Tree	Patala
9	25/03/2011	M V Sumanth	1580	Antony and Co. municipal	Tamil Nadu	<i>Tribulus terrestris</i>	Zygophyllaceae	Herb	Gokshuru
10	13/11/2010	K Ravi Kumar, R Murugan	1669	Jabbara MPCA	Chhattisgarh	<i>Uraria picta</i>	Fabaceae	Herb	Prishniparni

## Results

Dashamoola is a term used in Ayurveda that refers to a group of ten roots, which are widely used in various Ayurvedic formulations due to their therapeutic properties. These ten roots are derived from different plants, each contributing its unique medicinal qualities. Through maceration technique we studied on the xylem vessels in 10 species of roots of Dashamoola.

***Aegle marmelos*:** Xylem vessels were found to be reticulate (Figure 1: A), cylindrical barrel shaped, elongate, barrel shaped and with length (180-385 µm) and width (82-264 µm). Fibres are needle like, aseptate with narrow lumen, length (296 – 1126 µm) and width (12-37 µm). Procumbent, uniseriate with pitted and non-pitted ray cells.

***Clerodendrum phlomidis*:** Vessels were found to be elongated cylindrical with tapering end at one side, tapering ends at both sides, narrow pitted, reticulate (Figure 1: B) with length (30 – 408 µm) and width (64-608 µm). Fibres needle like, tapering both ends, grooves at one end and tapering on other end, V- shaped cutting at one end and other end is tapering, aseptate, narrow lumen, with length (228 – 890 µm) and width (12 – 89 µm). Ray cells uniseriate, procumbent, and pitted to non- pitted.

***Desmodium gangeticum*:** Vessels were found to be elongated-cylindrical, tapering ends, tapering end at one side, narrow pitted, and reticulate (Figure 1: C) to scalariform with length (49 – 154 µm) and width (48 – 110 µm). Fibres needle like, aseptate, tapering ends, tapering end at one side, narrow lumen with length (48 – 138 µm) and width (9 – 15 µm). Ray cells uniseriate, with upright cells, pitted to non- pitted cells.

***Gmelina arborea*:** Vessels were found to be elongated barrel, oval with tapering ends, reticulate (Figure 1: D), broad pitted, with length (153 – 458 µm) and width (489 – 801 µm). Fibres have tapering ends, aseptate, narrow to broad lumen, with length (224 – 438 µm) and width (112 – 219 µm). Xylem rays are uniseriate, with procumbent and upright, only upright cells with pitted to non-pitted cells.

***Oroxylum indicum*:** Vessels were found to be elongated cylindrical, short oval, barrel, reticulate (Figure 1: E), tapering one end, narrow pitted with length (99 – 549 µm) and width (20 – 246 µm). Fibres needle like, tapering both end with grooves present at one end, V- shaped cutting at one end, aseptate, narrow lumen, with length (706 – 1650 µm) and width (9 – 81 µm). Xylem rays are uniseriate, with few only procumbent cells, only upright cells, with few both cells, pitted to non-pitted cells.

***Stereospermum chelonoides*:** Vessels were found to be, elongated barrel, tapering ends, reticulate (Figure 1: G), broad to narrow pitted with length (229 – 370 µm) and width (36 – 458 µm). Fibres needle like tapering ends, grooves at one side and other side with tapering end, aseptate, narrow lumen with length (354 – 561 µm) and width (13 – 24 µm). Ray cells uniseriate, with only procumbent cell, only upright cells, pitted cells.

The root sample taken for study contained some fungal mycelium /hyphae in the vessels, fibres, and ray cells as the plant collected had been affected with fungus.

***Solanum anguivi*:** Vessels were found to be elongated cylindrical, scalariform (Figure 1: F), broad pitted with length (197 – 408 µm) and width (256 – 356 µm). Fibres needle like, aseptate, tapering ends, V- shaped cutting ends, tapering ends with entire grooves, broad lumen with length (296 – 1126

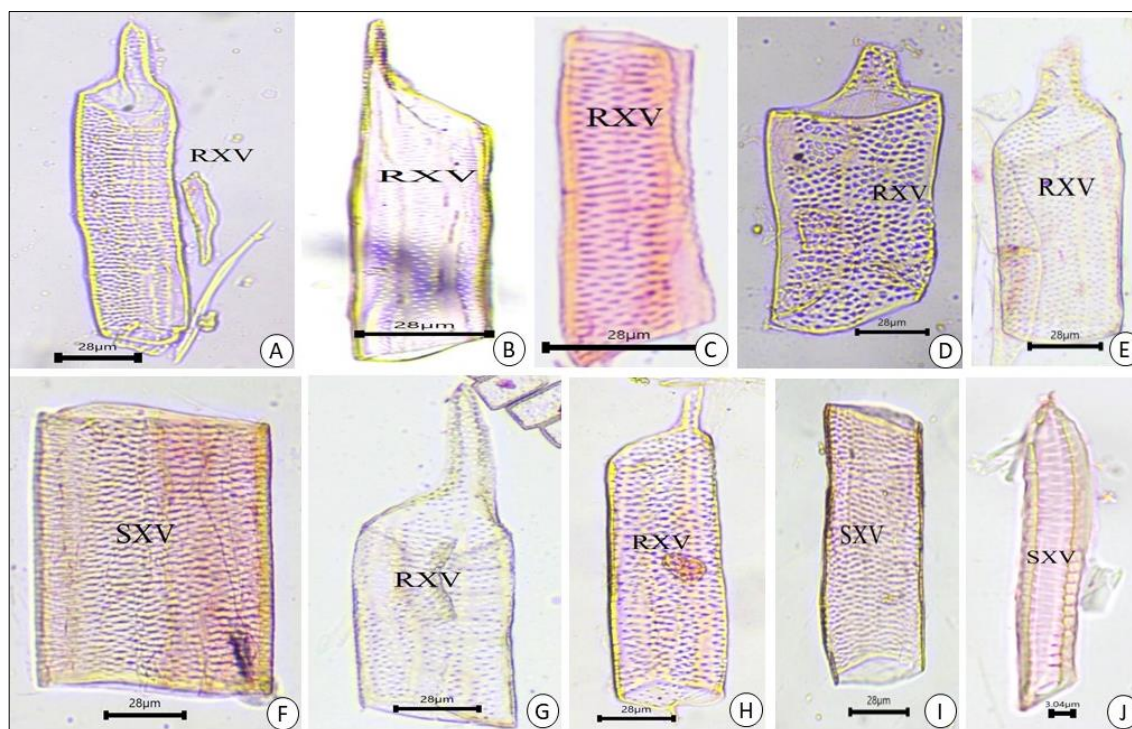
$\mu\text{m}$ ) and width (12 – 37  $\mu\text{m}$ ). Ray cells uniseriate, upright cells, pitted cells.

***S. virginianum***: Vessels were found to be elongated cylindrical, tapering ends, reticulate (Figure 1: H), narrow pitted with length (147-444  $\mu\text{m}$ ) and width (40-518  $\mu\text{m}$ ). Fibres needle like, tapering ends with grooves, tapering end at one side and other side tapering end with grooves, aseptate, narrow lumen with length (210 – 532  $\mu\text{m}$ ) and width (12 – 28  $\mu\text{m}$ ). Ray cells uniseriate, upright cells, non- pitted cells.

***Tribulus terrestris***: Vessels were found to be elongated cylindrical, short-oval, tapering ends at one side, scalariform (Figure 1: I), narrow pitted with length (92 – 163  $\mu\text{m}$ ) and

width (78 – 220  $\mu\text{m}$ ). Fibres needle like, tapering end at one side and other side with grooves, tapering ends, aseptate, narrow lumen with length (196 – 698  $\mu\text{m}$ ) and width (9 – 21  $\mu\text{m}$ ). Ray cells uniseriate, with few upright cells, few procumbent cells, and pitted to non- pitted cells.

***Uraria picta***: Vessels were found to be elongated cylindrical, scalariform (Figure 1: J), tapering end at one side, broad pitted with length (96 – 403  $\mu\text{m}$ ) and width (42 – 160  $\mu\text{m}$ ). Fibres needle like, tapering end at one side and other side tapering end with grooves, tapering ends with grooves at middle, aseptate, narrow to broad lumen with length (324 – 1390  $\mu\text{m}$ ) and width (8 – 85  $\mu\text{m}$ ). Ray cells uniseriate, with both upright and procumbent cells, pitted cells.



**Fig 1:** Xylem vessels of Dashamoola. A- *Aegle marmelos*; B - *Clerodendrum phlomidis*, C - *Desmodium gangeticum*; D-*Gmelina arborea*, E- *Oroxylum indicianum*, F- *Solanum anguivi*, G-*Stereospermum chelonoides*, H - *Solanum virginianum*; I - *Tribulus terrestris*; J *Uraria picta*. (RXV- Reticulate Xylem Vessels; SXV - Scalariform Xylem Vessels)

## Discussion

Vessels are the primary conductive cell type in angiosperms, which is typically broader in diameter than a tracheid and placed axially, one above the other, to form long tubes known as vessels. Most of the research works are done which explains the anatomical characters of leaf, stem and root. Several characters like vessels, parenchyma, fibres, ray cells in wood and hairs, cork, epidermis, stomata, mesophyll, petiole in leaf and cork, cortex, cortical bundles, pericycle, xylem, phloem in root, stem and leaves are studied (Metcalf & Chalk 1950) [5].

The present study elongate-cylindrical vessels are found in 6 species and barrel shaped vessels are found in 4 species. Bulged shape vessels are found in *C. phlomidis*, *G. arborea*, and *T. terrestris*. Vessels with one end tapering are found in *A. marmelos*, *D. gangeticum*, *S. chelonoides*, and *T. terrestris*.

Vessels with both tapering ends are found in 5 species of Dashamoola. Broad pitted xylem vessels are found in *G. arborea* and *U. picta*. Narrow pitted xylem vessels are found in *O. indicum*, *D. gangeticum*, *S. virginianum* and *T. terrestris*. Narrow to broad pitted xylem vessels is found in *C. phlomidis*, *S. chelonoides*, and *S. anguivi*. Reticulate type xylem vessels are found in 6 species. Scalariform type xylem vessels are found in 3 species and both type of xylem vessels is found in *D. gangeticum*. Vessels with large average length are found in *G. arborea* with 289.6  $\mu\text{m}$  length and xylem vessels with least average length are found in *D. gangeticum* with 116.6  $\mu\text{m}$  length, vessels with large average width are found in *G. arborea* with 337.8  $\mu\text{m}$  width and fibres with least average width are found in *U. picta* with 47.4  $\mu\text{m}$  width. More details of the vessels of these ten species on Table – 2.

**Table 2:** Comparison on xylem vessels of Dashmoola

Species	Character			
	Vessel shape	Vessel type	Vessel length (µm)	Vessel width (µm)
<i>A. marmelos</i>	Elongate-cylindrical, barrel, one side tapering end	Reticulate	285.9	176.2
<i>C. phlomidis</i>	Elongate-cylindrical, bulged, tapering at both the ends, broad pitted	Reticulate	260.3	165.4
<i>G. arborea</i>	Bulged elongate-cylindrical with oval and barrel, tapering at both ends, broad pitted	Reticulate	289.6	337.8
<i>O. indicum</i>	Elongate-short with oval and barrel, tapering one end narrow pitted	Reticulate	228.3	158
<i>S. chelonoides</i>	Elongate-barrel, tapering both ends, broad and narrow pitted	Reticulate	273.7	128.2
<i>D. gangeticum</i>	Elongate-cylindrical, tapering both ends, narrow pitted	Reticulate, Scalariform	116.6	87.8
<i>U. picta</i>	Elongate-cylindrical, tapering one at end, broad pitted	Scalariform	255.1	47.4
<i>S. anguivi</i>	Elongate-cylindrical, broad and narrow pitted.	Scalariform	229.6	149
<i>S. virginianum</i>	Elongate-cylindrical, tapering at both ends, narrow pitted	Reticulate	258.8	80.9
<i>T. terrestris</i>	Elongated short-cylindrical with oval and bulged. Tapering at one end narrow pitted.	Scalariform	129.8	90

According to our study needle like fibres with one end tapering are found in *A. marmelos*, *D. gangeticum*, *S. chelonoides* and *T. terrestris*. Fibres with tapering at both ends are found in *C. phlomidis*, *G. arborea*, *O. indicum*, *D. gangeticum*, *S. anguivi*, *S. virginianum* and *S. chelonoides*. Fibres with tapering at one end and other end tapering with grooves are found in *A. marmelos*, *C. phlomidis*, *G. arborea*, *S. chelonoides*, *U. picta*, *S. virginianum* and *T. terrestris*. Fibres with V- shaped cuttings at end are found in *C. phlomidis*, *O. indicum* and *S. anguivi*. Fibres with grooves at middle are found in *U. picta* species. Aseptate fibres are present in 10 species, fibres with narrow lumen are found in 7 species and fibres with broad lumen is found in *S. anguivi*, fibres with broad to narrow lumen are found in *G. arborea* and *U. picta*. Fibres with large average length are found in *A. marmelos* specie with 604.3 µm length and fibres with least

average length are found in *S. anguivi* with 363.4 µm length. Fibres with large average width are found in *S. virginianum* with 346.2 µm and fibres with least average width are found in *T. terrestris* with 15.2 µm. More details of the fibres and ray cells of these ten species on Table – 3.

Ray cells are uniseriate ray cells are found in 10 species of Dashmoola, procumbent cells are found in *A. marmelos* and *C. phlomidis* species, upright cells are found in *D. gangeticum*, *S. anguivi* and *S. virginianum* and both procumbent and upright cells are found in 5 species of Dashmoola. Pitted ray cells are found in *S. chelonoides*, *U. picta*, *S. anguivi* and non- pitted ray cells are found in *S. virginianum* and pitted to non- pitted ray cells are found in 6 species of Dashmoola. More details of the fibres and ray cells of these ten species on Table – 3.

**Table 3:** Comparison on xylem fibres and ray cells of Dashmoola

Species	Character				
	Fibre shape	Fibre length (µm)	Fibre width (µm)	Fibre lumen	Ray cell shapes
<i>A. marmelos</i>	Needle like, tapering both ends, V-shaped at one side and other end is tapering	604.3	18.6	Narrow	Procumbent
<i>C. phlomidis</i>	Needle like, tapering both ends, V-shaped at one side and other end is tapering.	518.1	30.2	Narrow	Procumbent
<i>G. arborea</i>	Needle like, tapering both ends, grooves at one end and other tapering end	676.6	27.6	Narrow to broad	Procumbent, upright
<i>O. indicum</i>	Needle like, tapering at both ends with grooves at one end, V- shaped end.	825.6	29	Narrow	Procumbent, upright
<i>S. chelonoides</i>	Needle like, tapering both ends and with grooves.	446	17.8	Narrow	Procumbent, upright
<i>D. gangeticum</i>	Needle like, tapering at both ends	427.9	16.9	Narrow	Upright
<i>U. picta</i>	Needle like, tapering one end and other end tapering with grooves	932.7	42.5	Narrow to broad	Procumbent, upright
<i>S. anguivi</i>	Needle like, tapering at both ends, V-shaped cutting at both ends	363.4	19.2	Broad	Upright
<i>S. virginianum</i>	Needle like, tapering at both ends with entire grooves	381.4	346.2	Narrow	Upright
<i>T. terrestris</i>	Needle like, tapering one end and other end with grooves	464	15.2	Narrow	Procumbent, upright

## Conclusion

Dashmoola is popular Ayurveda drug which is combination of medicinal plants and herbs. Vessels are reticulate, scalariform with pitted and non-pitted vessels, narrow broad lumen with tapering end. Xylem fibers are with tapering ends and grooves narrow to broad lumen characters of the species are identified. This type of study can be used for finding adulteration and substitutes of these plants by other plants.

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